

***Unresolved Transition Array (UTA) Emission from
Highly-charged Ions in Heavy-element Plasmas by a
Dual-laser Pulse Irradiation***

Recent progress in our laboratory

Takeshi Higashiguchi

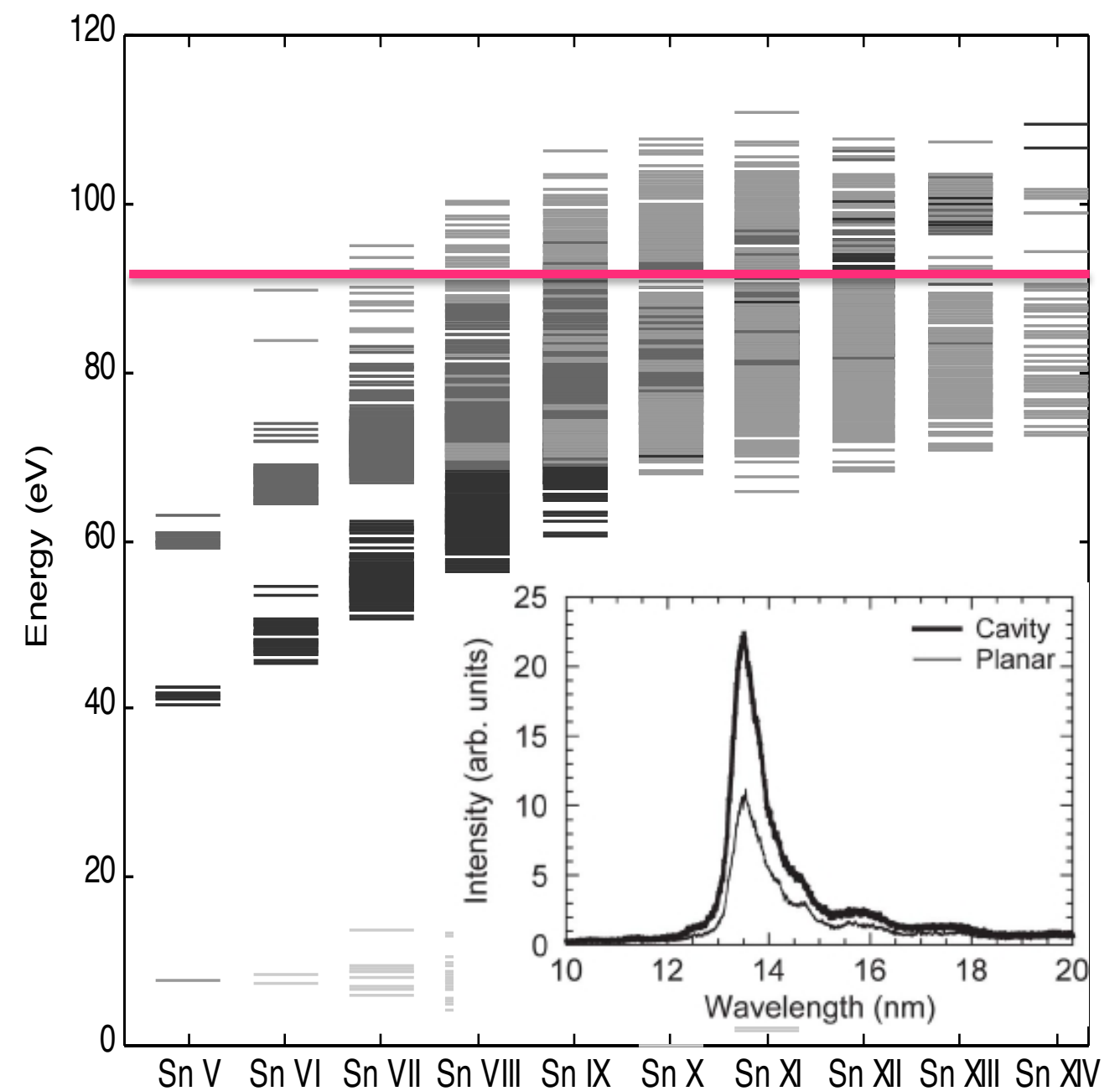
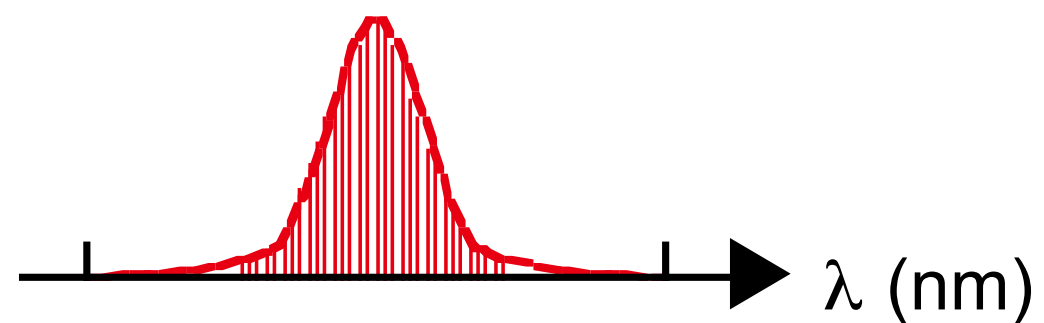
Utsunomiya University, Japan

Scheme for high-energy emission: **unresolved transition array**

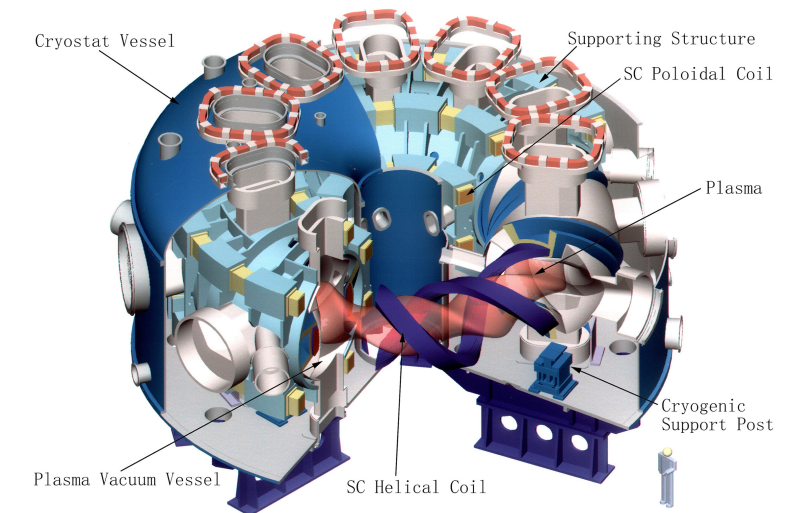
(a) Line spectrum



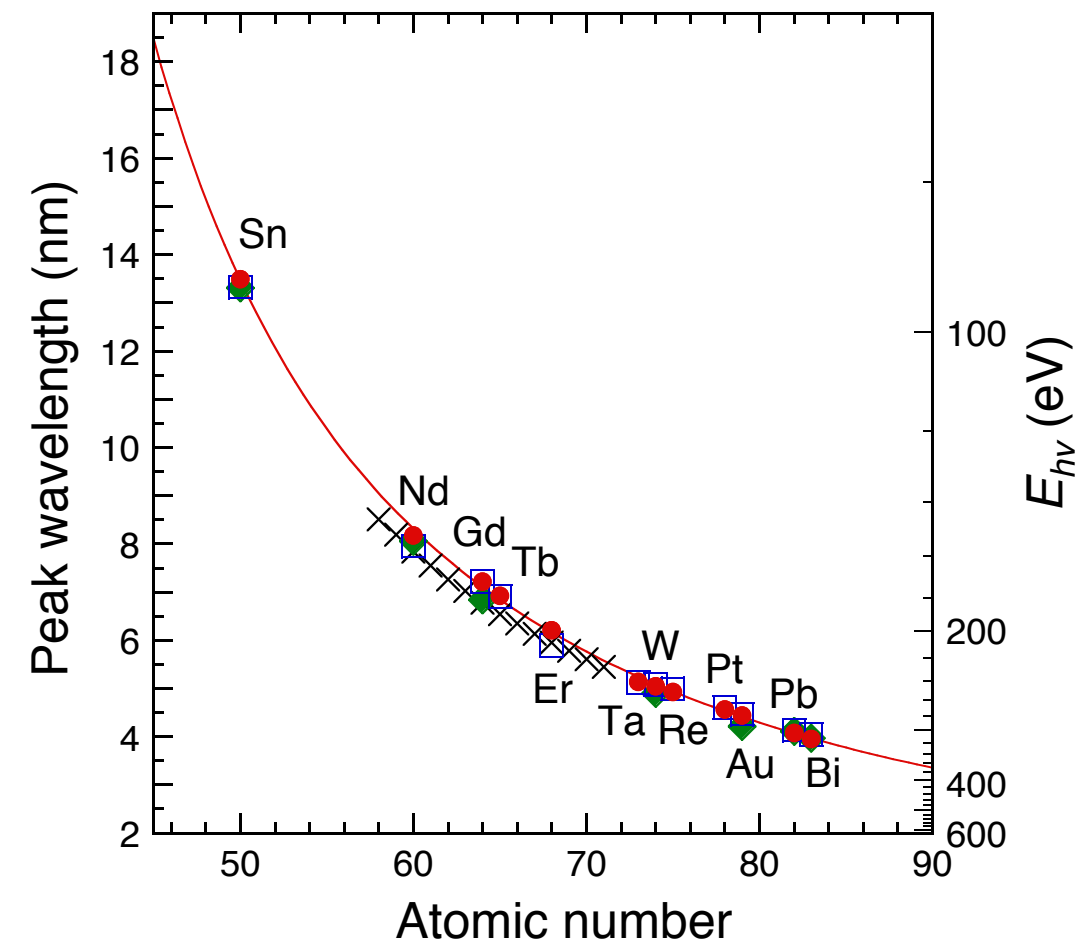
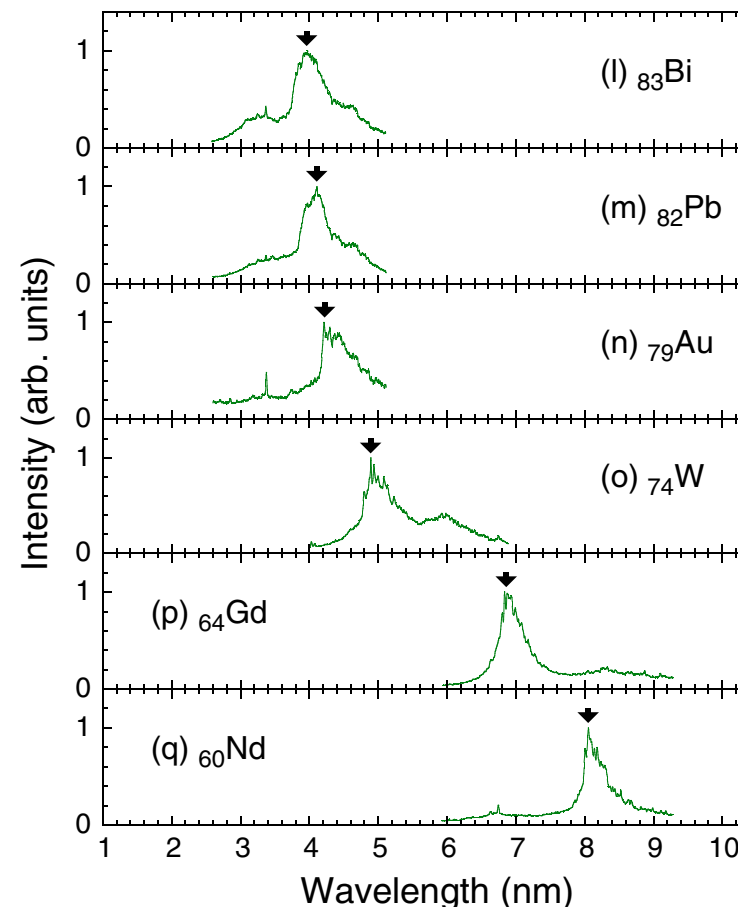
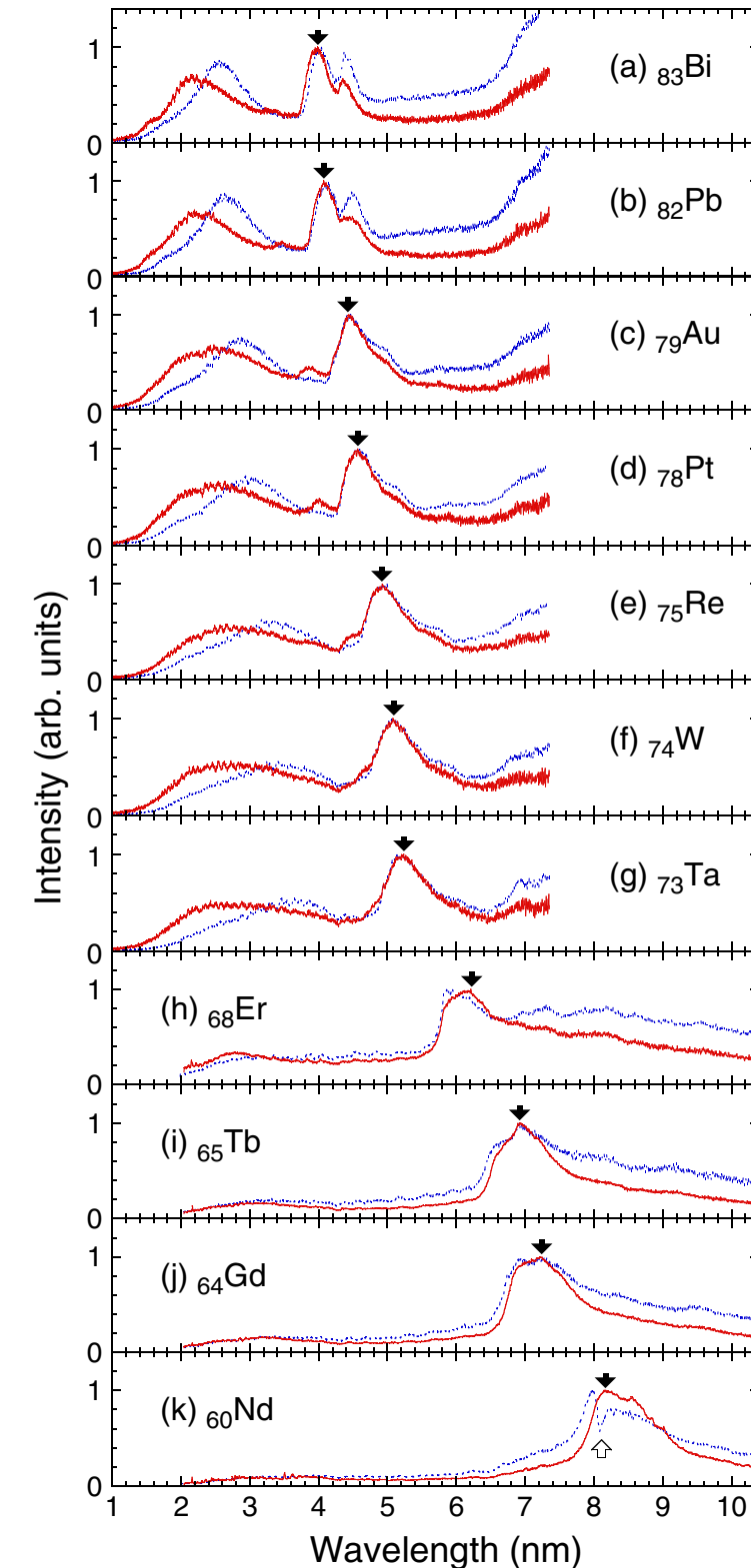
(b) UTA



Experiments: Quasi-Moseley's law



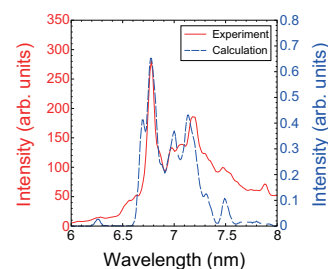
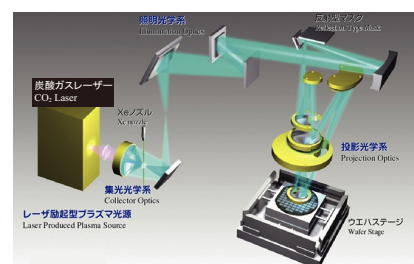
$$\lambda = (21.86 \pm 12.09) \times \frac{1}{R_{\infty}} \times [Z - (23.23 \pm 2.87)]^{-(1.52 \pm 0.12)}$$



Toward a single shot flash source in WW for Bio Photo **in LAB**

Lithography

EUV & BEUV source study
Wavelength: 13.5 & 6.x nm



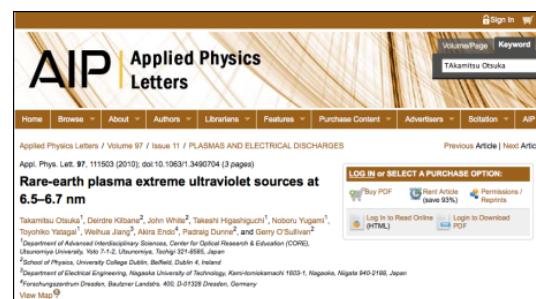
CE ~ 5%

Shorter wavelength



Shorter-wavelength extreme-UV sources below 10nm

Takeshi Higashiguchi, Takamitsu Otsuka, Noboru Yugami, Weihua Jiang, Akira Endo, Padraig Dunne, Bowen Li, and Gerry O'Sullivan

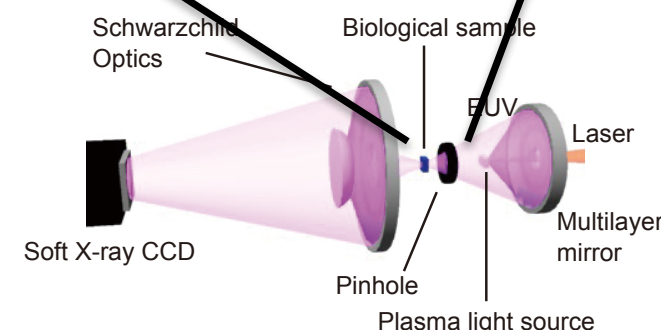
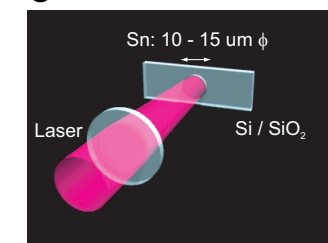
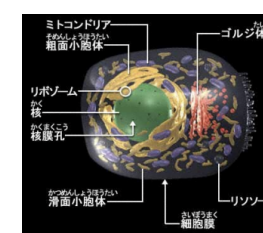


Life Innovation

Compact source development for Bio.
Wavelength: 2-4 nm

In vivo cell observation

Original micro source

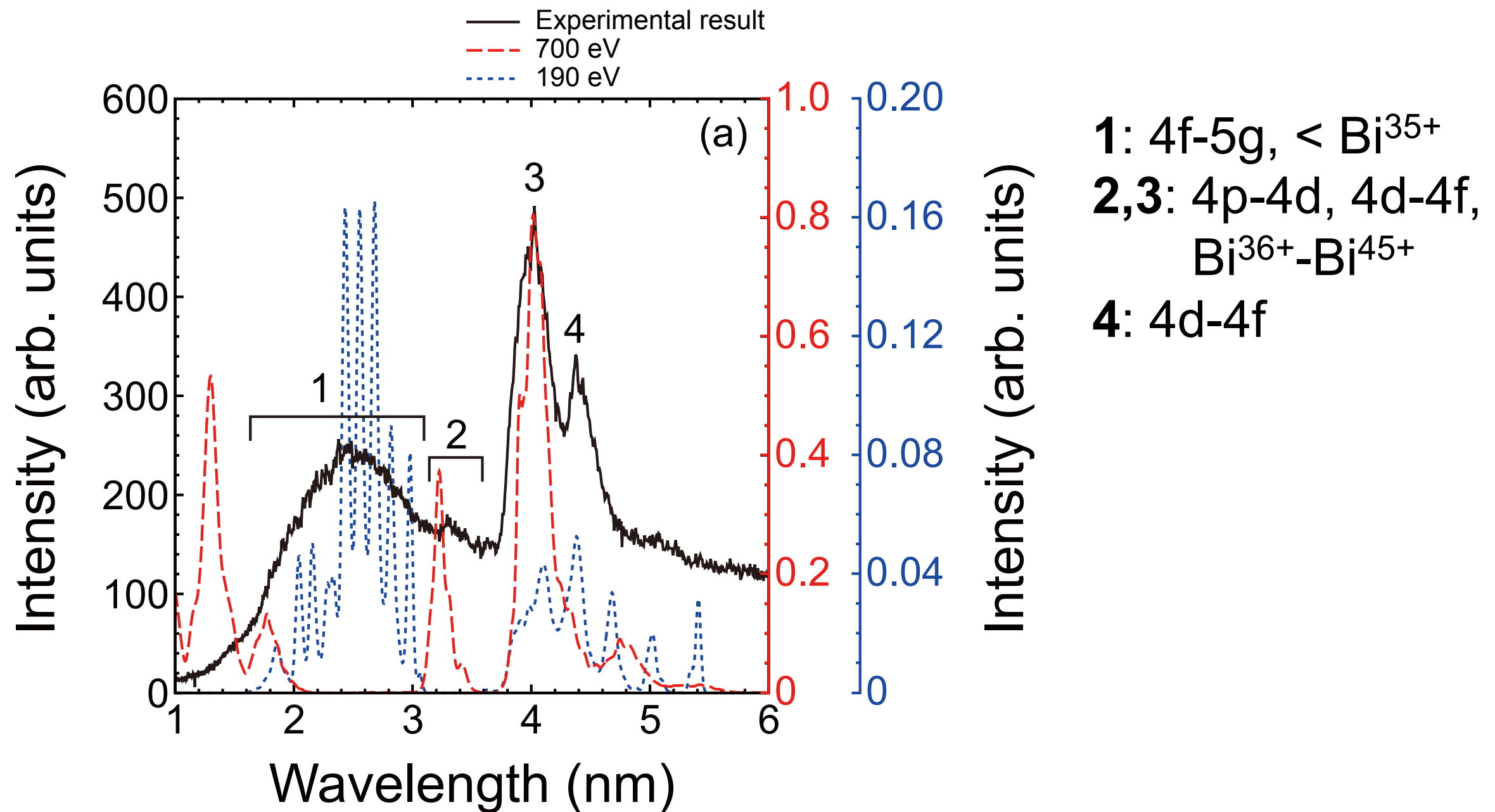


Single shot, flash biological imaging

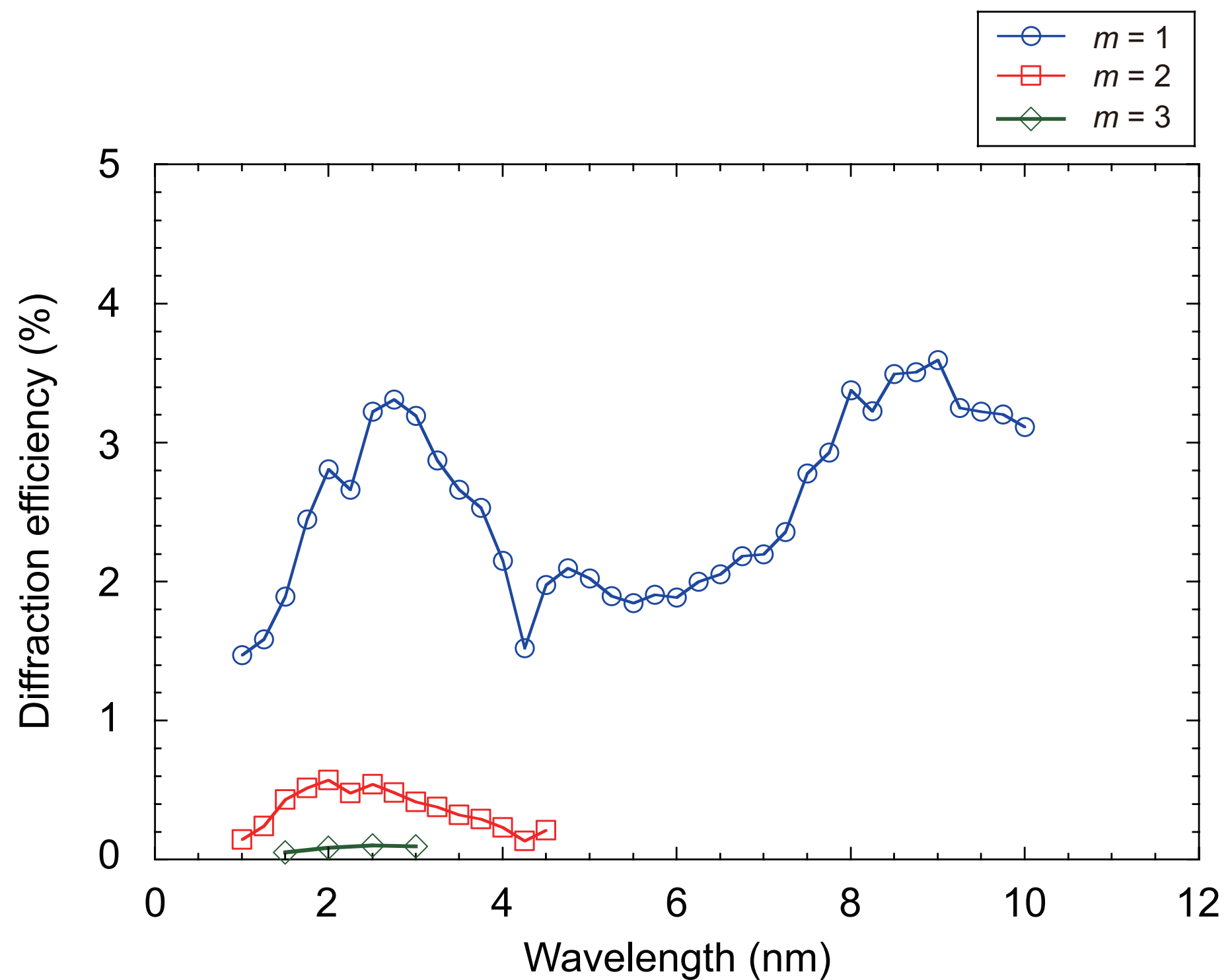
WW 100-μJ at 100-mJ laser

CE ~ 0.1%, 100 μJ (?)

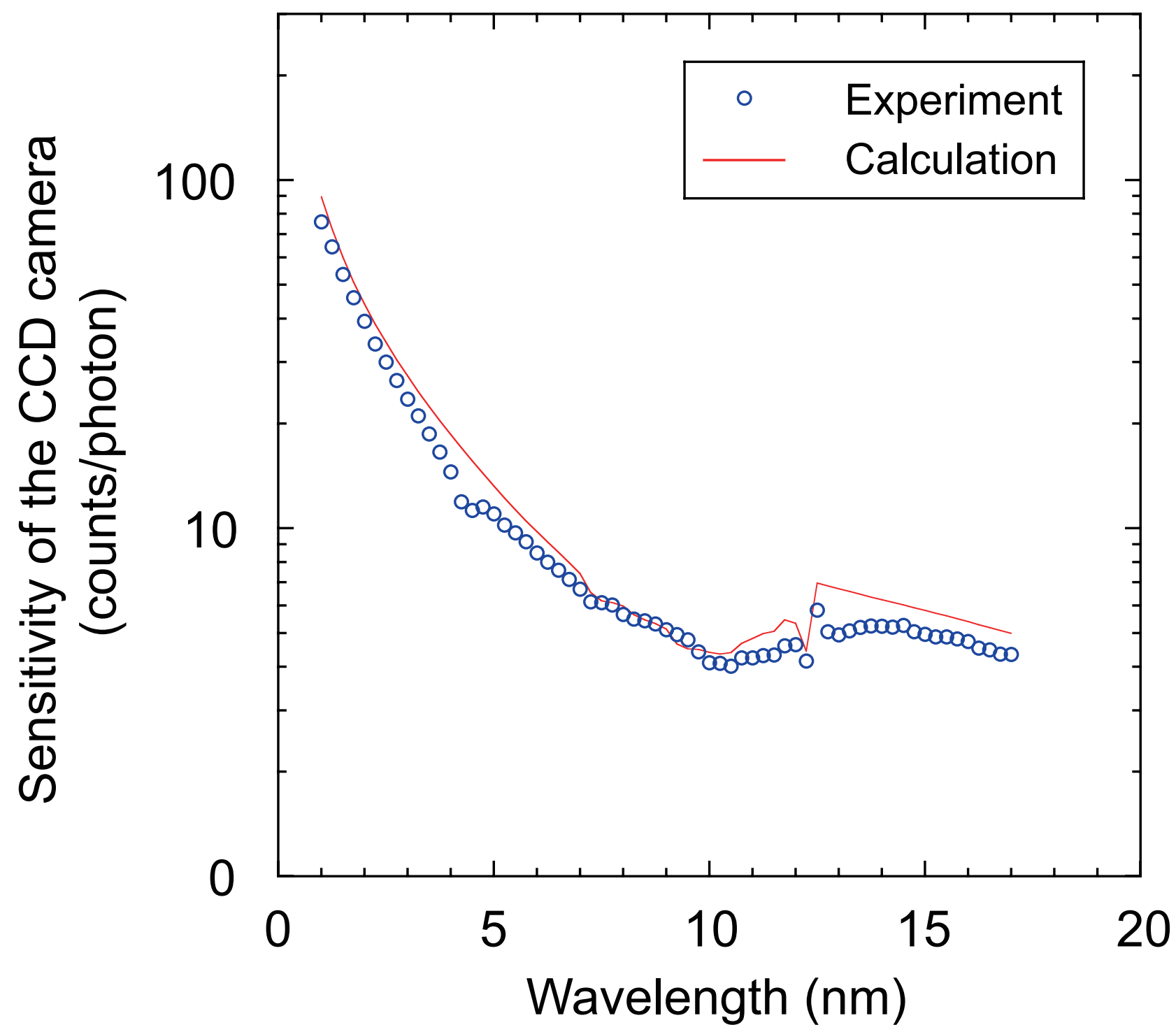
Low temperature result from Bi by 150-ps laser



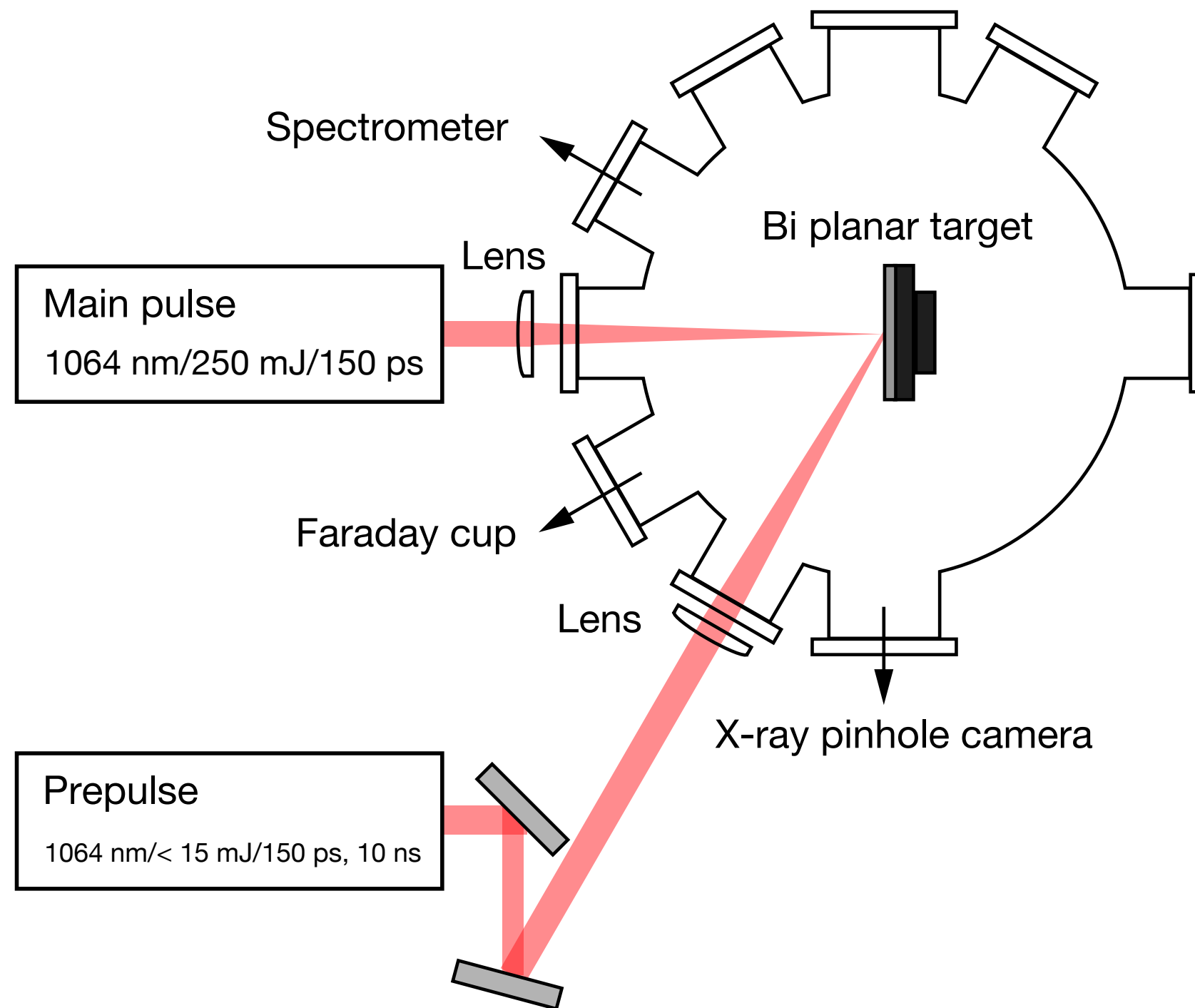
Calibration of the grating in 1-10 nm



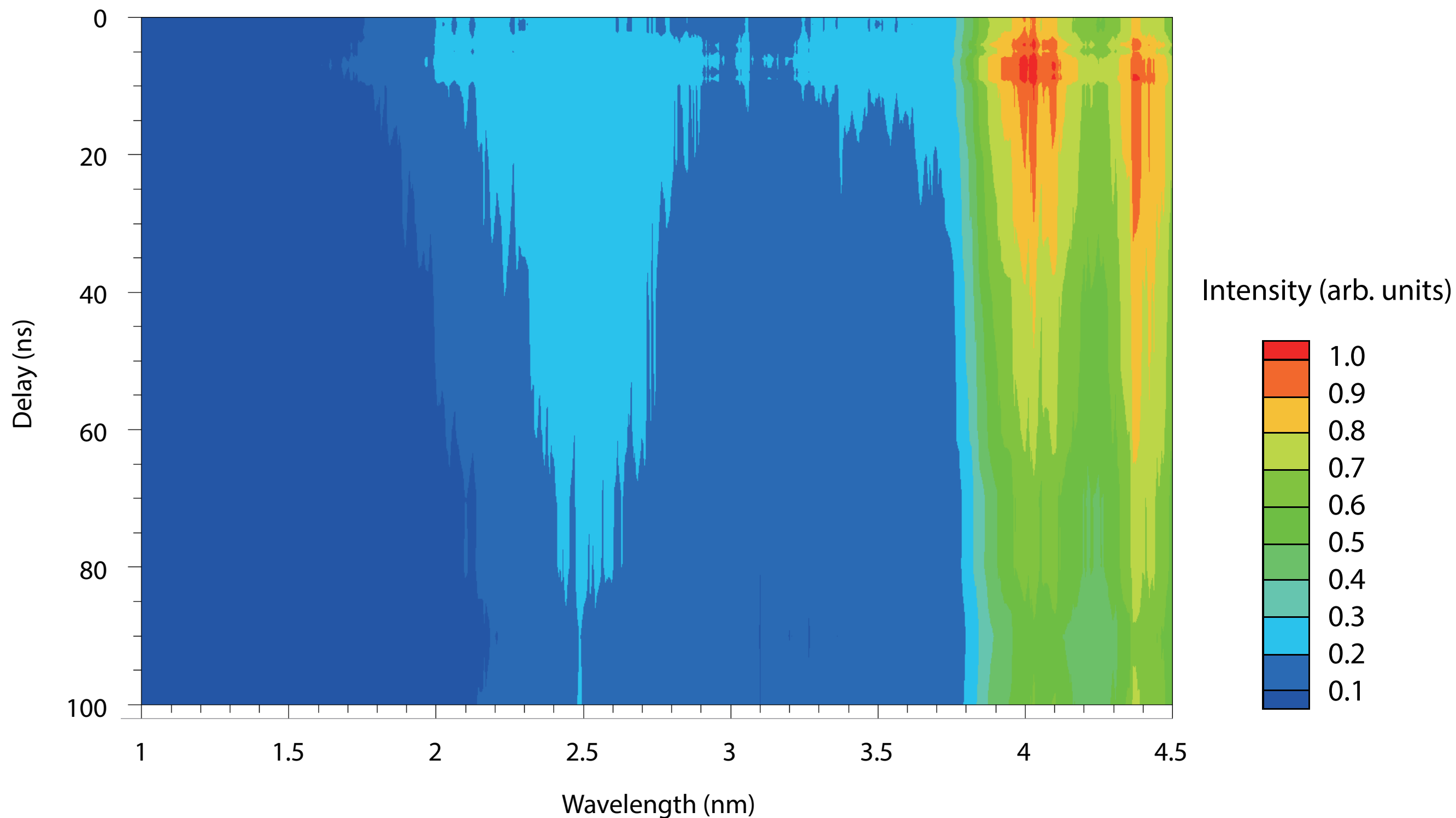
Calibration of the x-ray CCD sensor



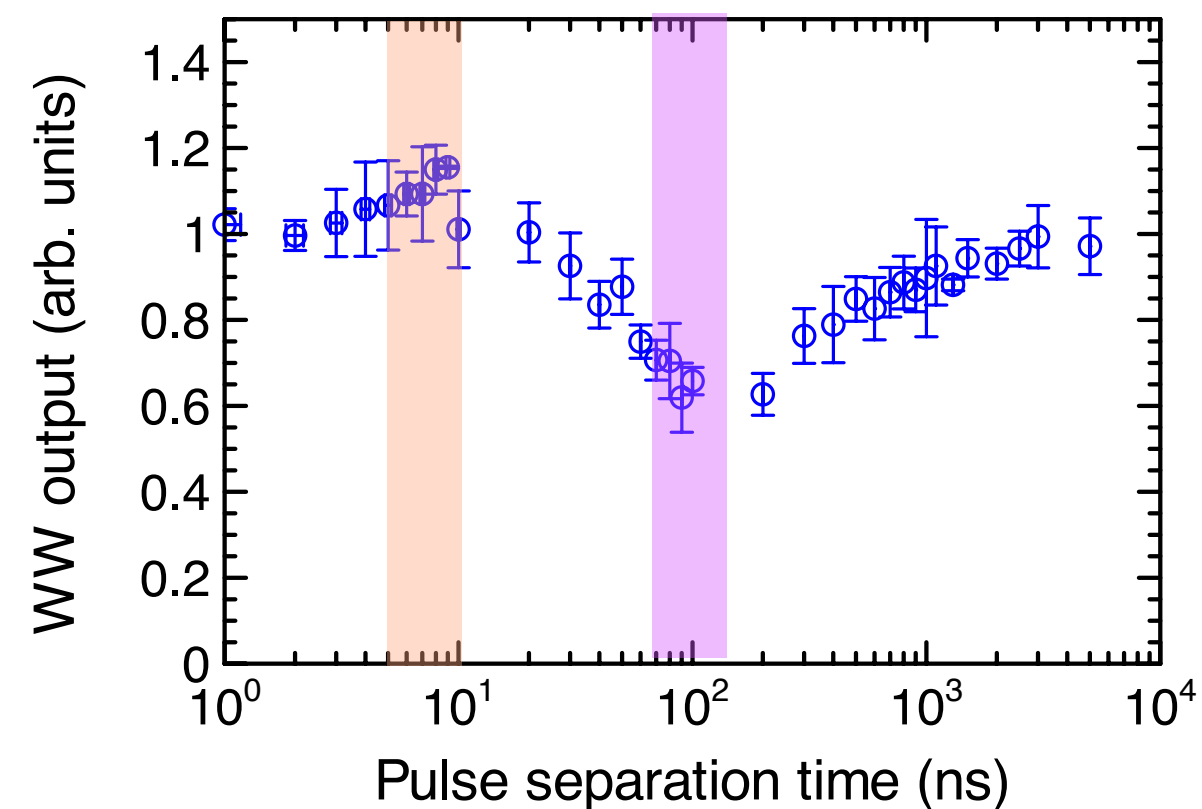
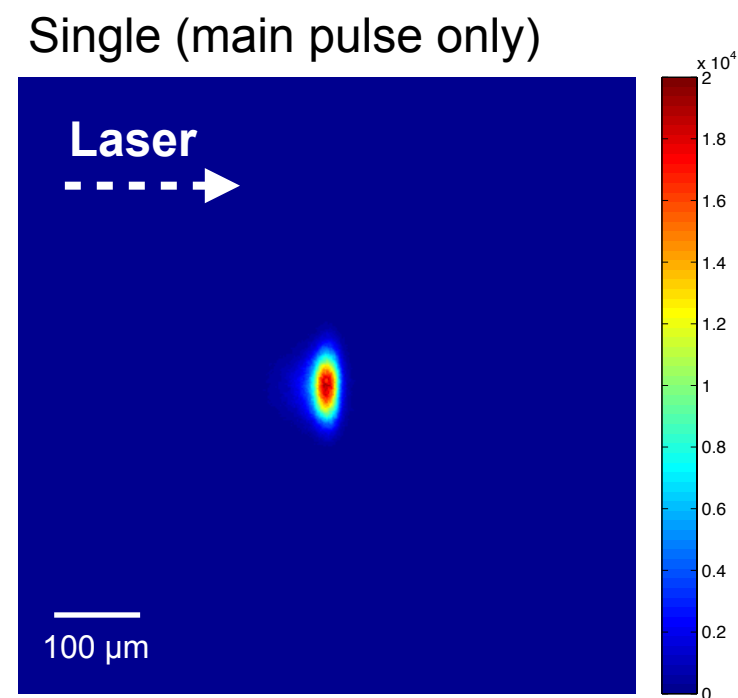
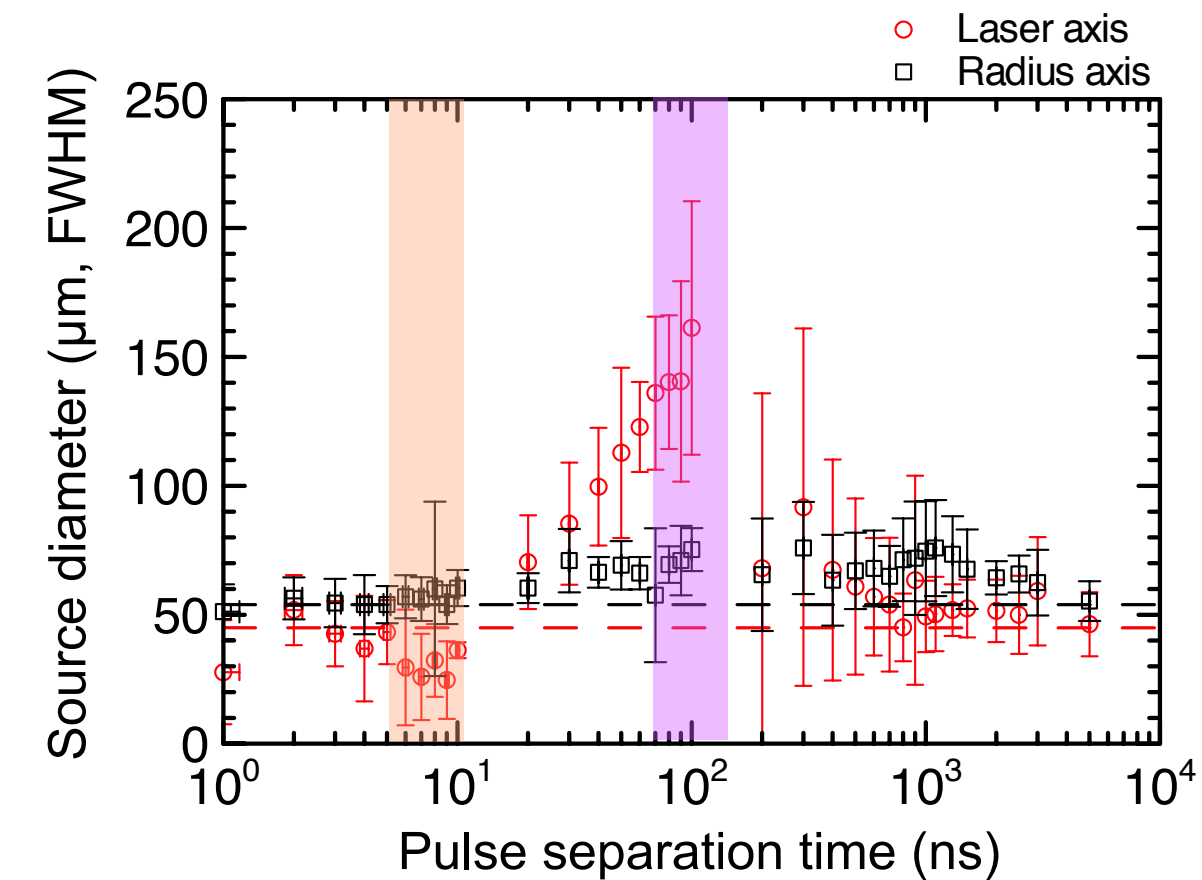
Spectral active control for **dual laser pulse irradiation**



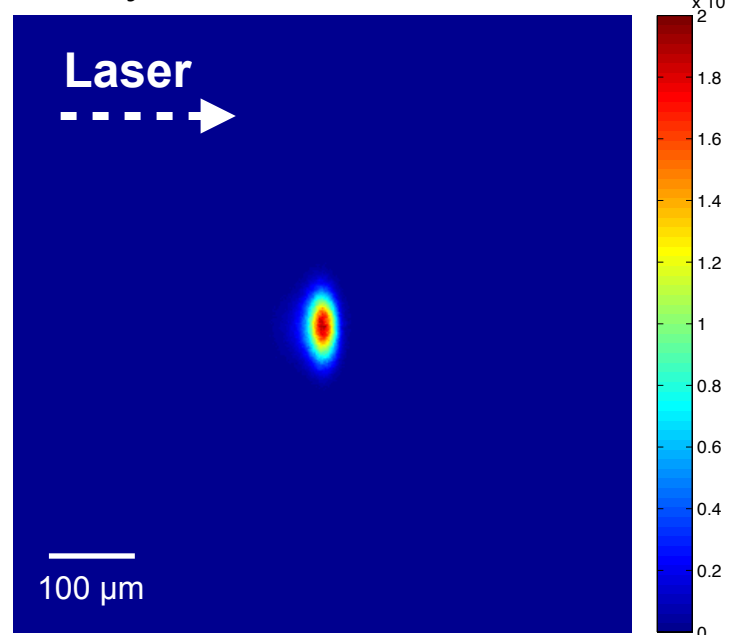
Spectral intensity of dual laser irradiation



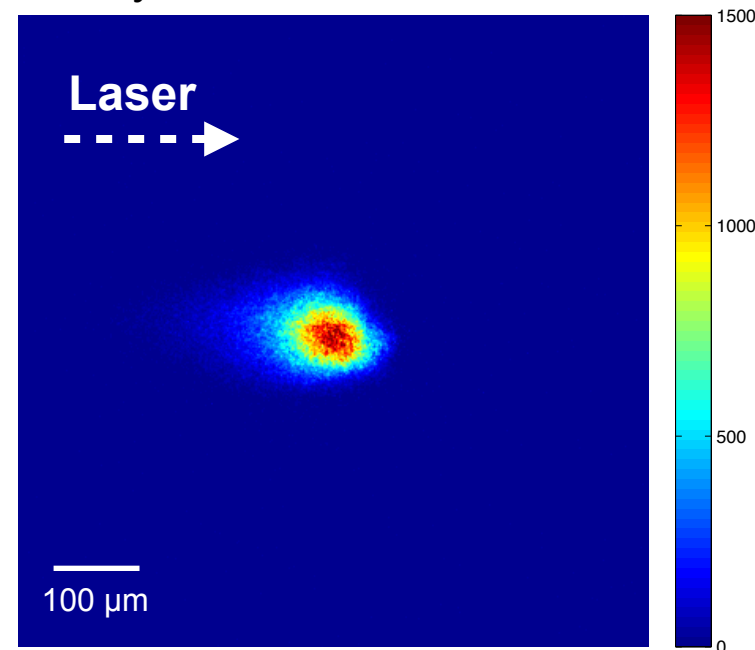
Enhancement around 7 ns & absorption around 100 ns



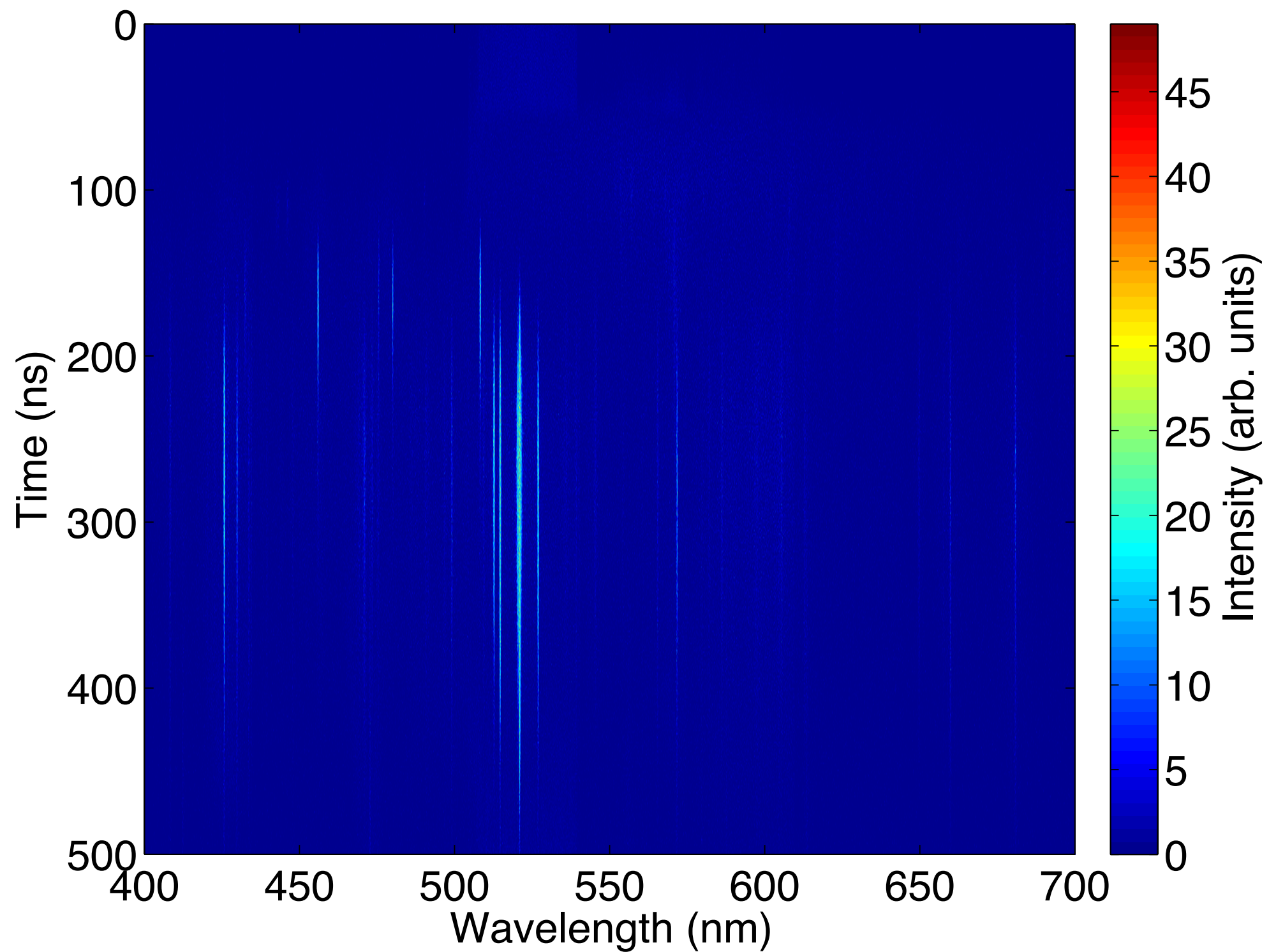
Delay = 7 ns



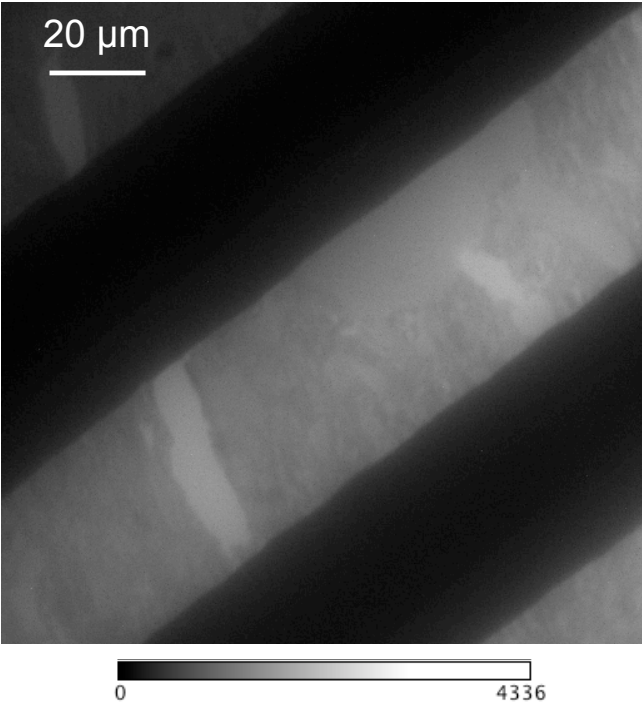
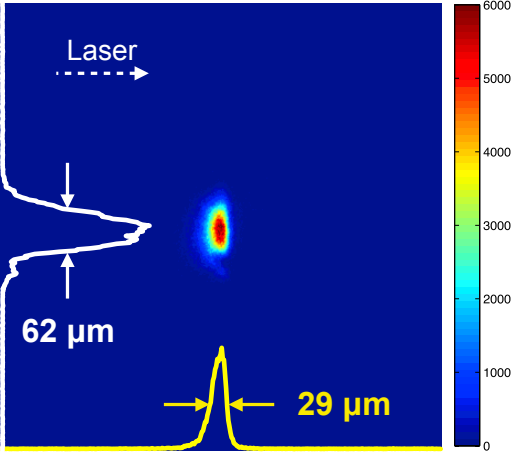
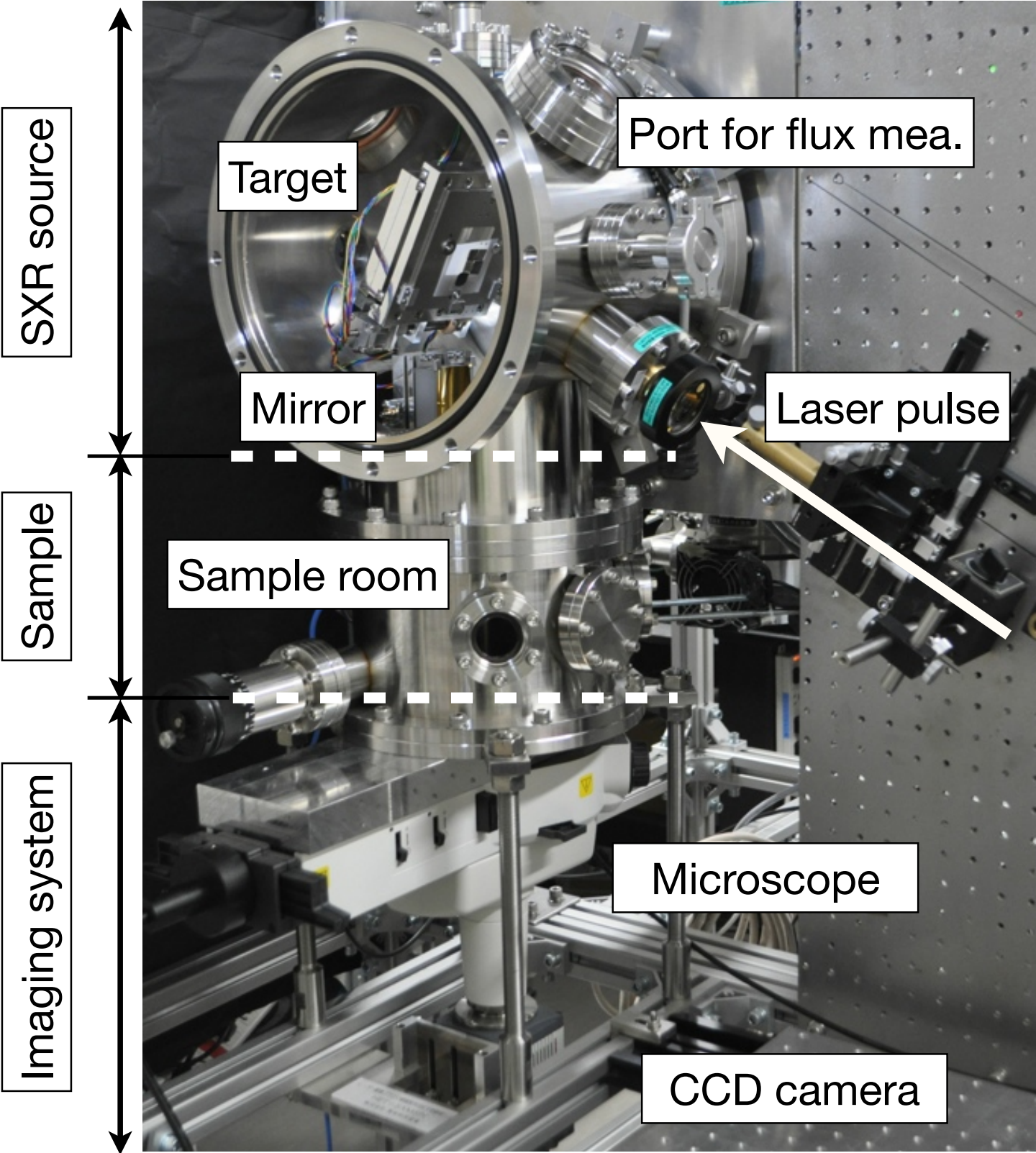
Delay = 100 ns



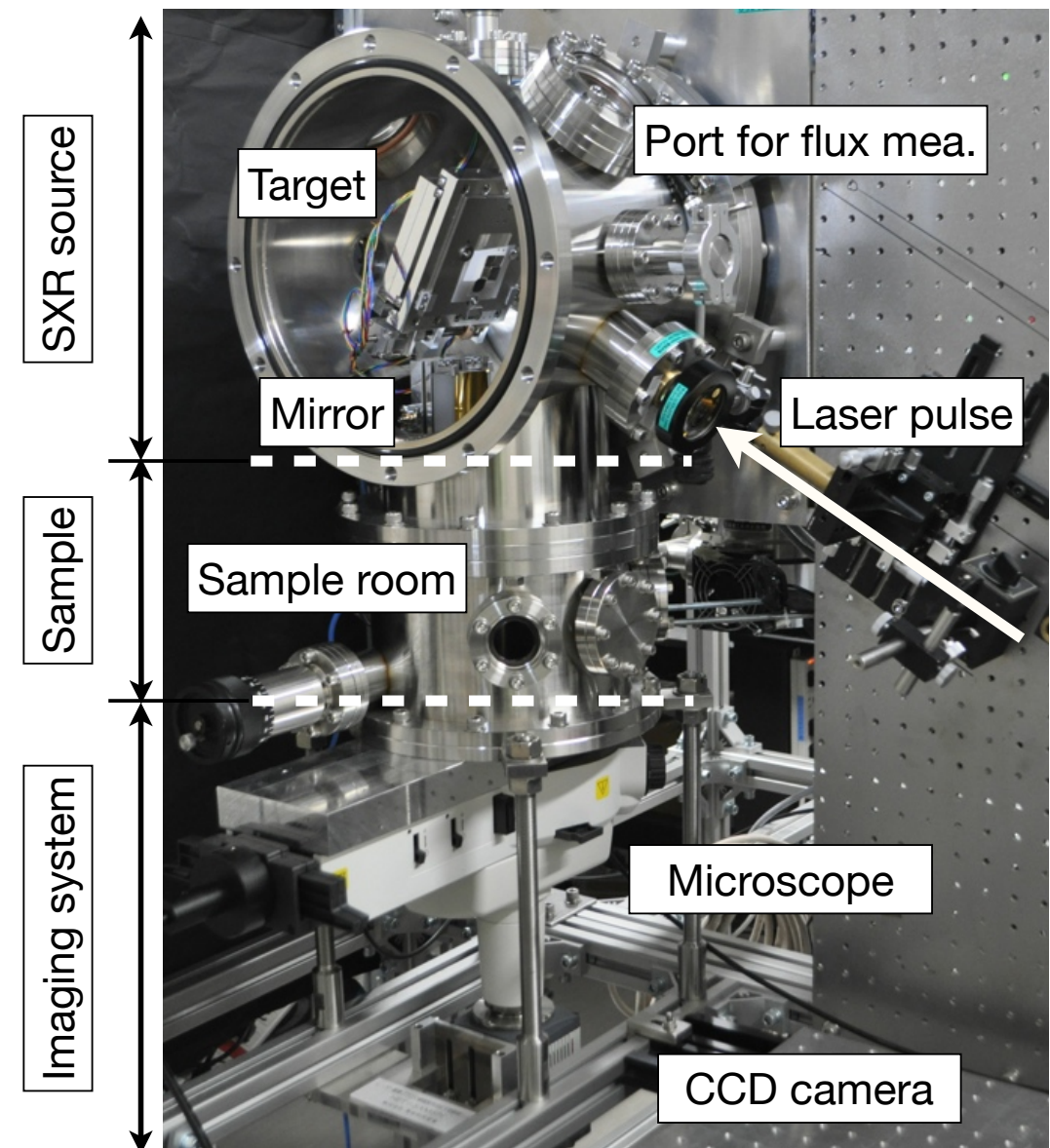
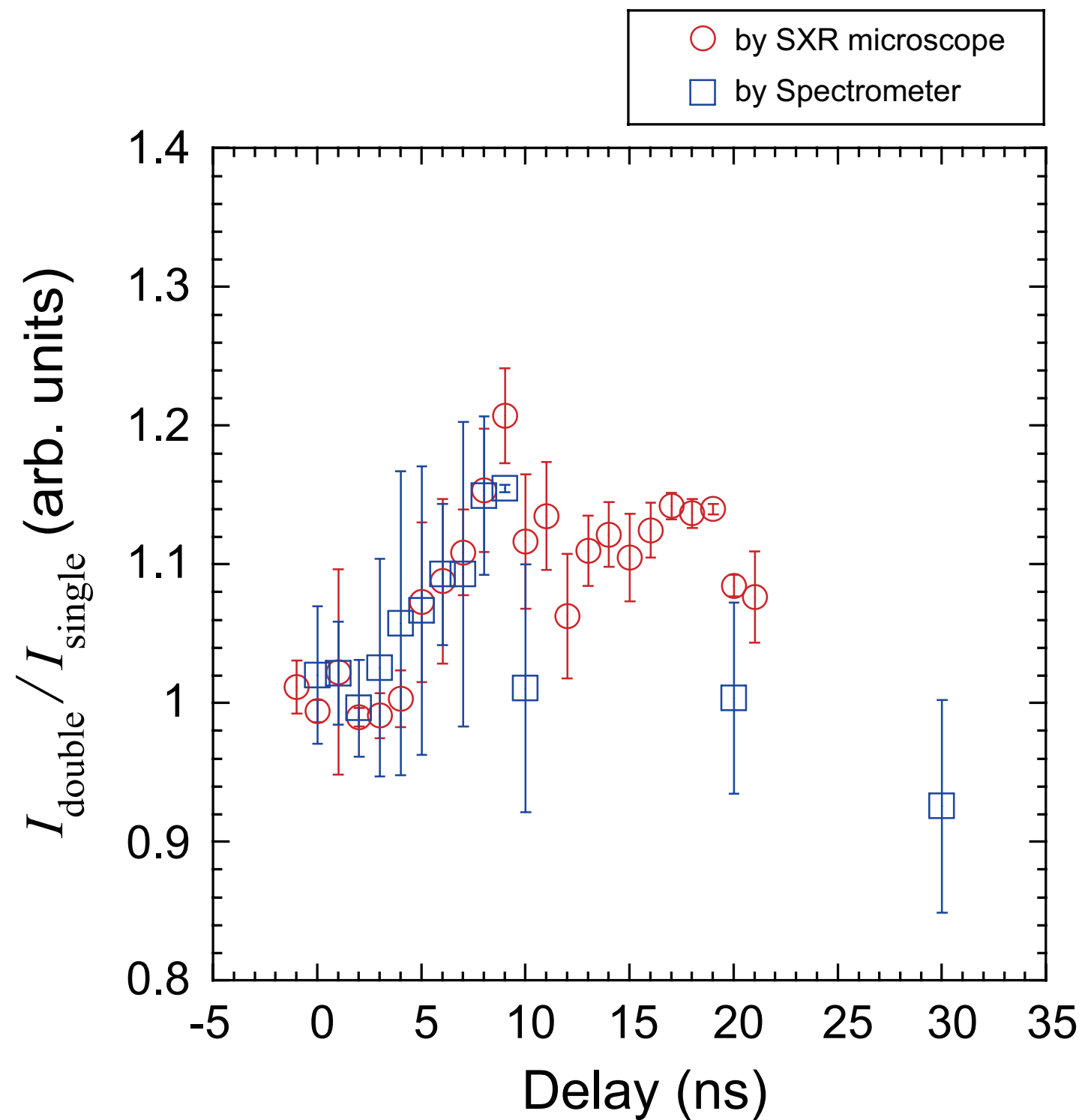
Time-resolved visible spectrum from **Bi** plasma



Microscope in water window soft x-ray **in Lab**



Enhancement of image intensity by **dual laser irradiation**



Summary

We characterized the emission property of the laser-produced plasma for efficient UTA EUV sources.

